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Research paper

Biodiverse perennial meadows have aesthetic value and increase residents' perceptions of site quality in urban green-space

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HIGHLIGHTS

- Perennial meadows increased perceived quality and appreciation of urban green-space.
- Meadows were preferred to herbaceous borders, bedding planting & mown amenity grass.
- Meadows that contained more plant species had the highest preference scores.
- Structurally diverse meadows were preferred to short meadows.
- Giving information about meadows ecosystem service benefits promotes acceptance.

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ABSTRACT

We used photo-elicitation studies and a controlled perennial meadow creation experiment at ten urban green-spaces in southern England (five experimental sites and five control sites) to assess green-space visitors' responses to urban meadows. Multiple meadows, which varied in their structural diversity (height) and plant species richness, were created at each experimental site. Photo elicitation demonstrated that meadows were generally preferred to herbaceous borders and formal bedding planting. Moreover, our experimental meadows had higher preference scores than a treatment that replicated mown amenity grassland, and meadow creation improved site quality and appreciation across a wide range of people. Meadows that contained more plant species and some structural diversity (i.e. were tall or of medium height) were most preferred. The magnitude of these preferences was lower amongst people that used the sites the most, probably due to a strong attachment to the site, i.e. sense of place. People with greater eco-centricity (i.e. those who used the countryside more frequently, had greater ability to identify plant species and exhibited more support for conservation) responded more positively to meadow vegetation. Crucially a wide range of respondents was willing to tolerate the appearance of meadows outside the flowering season, especially when provided with information on their biodiversity and aesthetic benefits and potential cost savings (from reduced cutting frequencies). Re-designing urban green-spaces and parks through the creation of species rich meadows can provide a win–win strategy for biodiversity and people, and potentially improve connections between the two.

1. Introduction

The benefits of urban green-space for biodiversity and the provision of ecosystem services are well established (e.g. Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007; Kong, Yin, Nakagoshi, & Zong, 2010). Urban green-space is important for human health and well-being (Andersson, Tengo, McPherson, & Kremer, 2014; Dias, Fargione, Chapin, & Tilman, 2006), not least because over half of the world's human population now reside in cities, and this proportion is increasing rapidly (United Nations Development Program, 2011). Despite recognition of its importance, urban green-space is being lost across much of the globe (Haas, Furberg, & Ban, 2015; McDonald, Foreman, & Kareiva, 2010; Sheng & Thuzar, 2012). The drivers of this loss vary spatially and temporally, but include planning policies that restrict urban sprawl and thus promote densification of urban areas (Dallimer et al., 2011; Haaland & van den

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Bosch, 2015), reductions in size of public green-spaces as a result of land sales (Chen & Hu, 2015), the redevelopment of derelict land (Pauleit, Ennos, & Golding, 2005), and householders' decisions to replace gardens with impervious surfaces for alternative uses, such as house extensions and car-parking (RHS, 2015). The pressures driving the loss of urban green-space are likely to increase, with global urban land-cover projected to triple between 2000 and 2030 (Seto, Guneralp, & Hutyra, 2012).

Mown grassland, i.e. amenity grassland or lawn, is one of the commonest forms of urban green-space, especially in temperate regions (Irvine et al., 2009; Kazmierczak, Armitage, & James, 2010). Whilst providing space for recreation, urban mown grassland supports relatively little biodiversity. Lawns do contribute to overall native plant richness in urban gardens (Thompson, Hodgson, Smith, Warren, & Gaston, 2004), but are typically very homogenous and are characterised by a few highly dominant grass species (Dover, 2015). This lack of heterogeneity typically supports lower diversity of other taxonomic groups, such as wild bees, spiders and soil macrofauna (Hostetler & McIntyre, 2001; Shochat, Stefanov, Whitehouse, & Faeth, 2004; Smith, Chapman, & Eggleton, 2006), and reduced provision of many ecosystem services compared to less intensively managed alternatives (Garbuzov, Fensome, & Ratnieks, 2015; Meurk, Blaschke, & Simcock, 2013). Mown amenity grassland also requires regular cutting, typically 15 times a year in the UK (Woodland Trust, 2011), and climate change has already increased growing season length and duration of mowing period by about 25% between 1984 and 2004 (Sparks, Croxton, Collinson, & Grisenthwaite, 2005). High and increasing mowing frequencies are incompatible with the decreasing financial resources available for managing urban green-space in many parts of the world (Heritage Lottery Fund, 2014; Walls, 2009). This has led to increasing interest in the adoption of vegetation types requiring less intensive management (and hence cost) whilst providing improved biodiversity and ecosystem services (Briffett, 2001; Klaus, 2013).

Urban meadows (i.e. naturalistic, unmown grassland with or without flowering forbs) provide an alternative landcover type to mown amenity grassland, and whilst meadows are increasingly being established in some urban areas, they still comprise a tiny fraction of urban green-space (Hitchmough & De la Fleur, 2006: Loder, 2014). Claims are frequently made regarding the ecological, educational, aesthetic and sustainability benefits of meadows in urban areas (Ahern & Boughton, 1994; Standish, Hobbs, & Miller, 2013) but are based on limited, and largely observational, evidence (Klaus, 2013). This reflects the more general need for studies that quantify the relationships between urban biodiversity and cultural ecosystem services (Shwartz, Turbé, Simon, & Julliard, 2014). Initial work on urban meadows suggests that whilst people are theoretically supportive of the enhanced biodiversity value of urban meadows their presence does not increase peoples' enjoyment of a site (Garbuzov et al., 2015), perhaps because many people do not perceive a change in biodiversity (Shwartz et al., 2014). These results are surprising, as much research conducted on vegetation preference and the factors that influence its attractiveness suggests that the latter include characteristics frequently found in meadow vegetation, including colour, and structural and floristic diversity (Hands & Brown 2002; Lindemann-Matthies & Bose, 2007; Lindemann-Matthies, Junge, & Matthies, 2010). More work is thus needed to understand how people respond to the creation of meadow vegetation in urban environments before it can be advocated as a management tool to enhance biodiversity and ecosystem service provision in urban green-spaces currently dominated by mown amenity grassland.

We established urban meadows in a replicated design across five public green spaces in southern England; at each site meadows were created that varied in their structure (height) and number of plant species (grasses and forbs). Sites where we created meadows were paired with similar nearby public green spaces without meadows. Users of these green spaces were interviewed to address three broad questions: (i) How do people value urban meadows relative to alternative planting styles commonly used in parks? (ii) Does the presence of the urban meadows alter users' perceptions of green-space quality? (iii) How do structural diversity and plant species richness influence people's preferences for alternative meadow types. In all these analyses we assessed how respondents' characteristics influence their responses to meadows, focusing on their usage of the site, measures of their connection to the countryside and wildlife, and socio-demographic traits. Finally, as all previous work on the aesthetic value of urban meadows has focused on their appearance during the flowering season we assess (iv) whether people are willing to tolerate the appearance of the meadows during other seasons, and how tolerance changes when information is provided on their biodiversity and other benefits.

2. Methods

2.1. Site selection

Meadow plots were established in five areas of mown grassland situated in urban green spaces in Bedford and Luton, Southern England (Bedford sites: Chiltern Avenue, Goldington Green, Brickhill Heights, Jubilee Park; Luton site: Bramingham Road; Fig. S1). All sites are surrounded by residential areas and visited frequently by local people. An indicator of the socio-economic profile is provided by the Multiple Index of Deprivation (National Office for Statistics, 2015) of the lower super output area surrounding each site. This is the smallest spatial unit used in the National Census, and is typically slightly larger than the area represented by a full post-code. This deprivation index varies from 1 to 100, with higher numbers indicating greater deprivation. The deprivation indices of our sites range from 5 (Chiltern Avenue, placing it in the 10% least deprived neighbourhoods in England) to 39 (Goldington Green, placing it in the 20% most deprived neighbourhoods). Each experimental site was paired with a nearby control site that was as similar as possible in its size, vegetation features, type of surrounding residential development and deprivation index.

2.2. Experimental design

There were nine meadow treatments spanning two axes of variation: plant species richness (low, medium and high) and structural diversity (short, medium and tall; Fig. 1). Plant species richness was manipulated by sowing seed mixes that varied in their total species richness. The low plant species richness seed mixes only contained grasses and the short plots containing this mix replicated mown amenity grassland (Table S1). When seed mixes contained forbs, variation in flower colour between the mixes was minimized through species selection. Seed mixes were randomly allocated to standardised rectangular plots ($250\,m^2$) within each site. There were 5 m gaps (of original short mown turf) between plots. All species were perennial, as annual meadows typically need re-sowing at regular intervals, thus increasing costs. All species were native to southern England. Structure was partly determined through plant selection but primarily controlled with different cutting regimes; short plots were cut every 4 weeks (average height c. 5 cm); medium height plots were cut twice a year (April and September, average height c. 50 cm) and the tall plots were cut once a year (February, average height 100 cm).

Plots were first sown in April 2013 and hand weeded during July 2013 to remove non-sown species. Some supplementary sowing was carried out in autumn 2013 where necessary to aid full establishment. One plot (Jubilee Park) was fully reseeded in April 2014

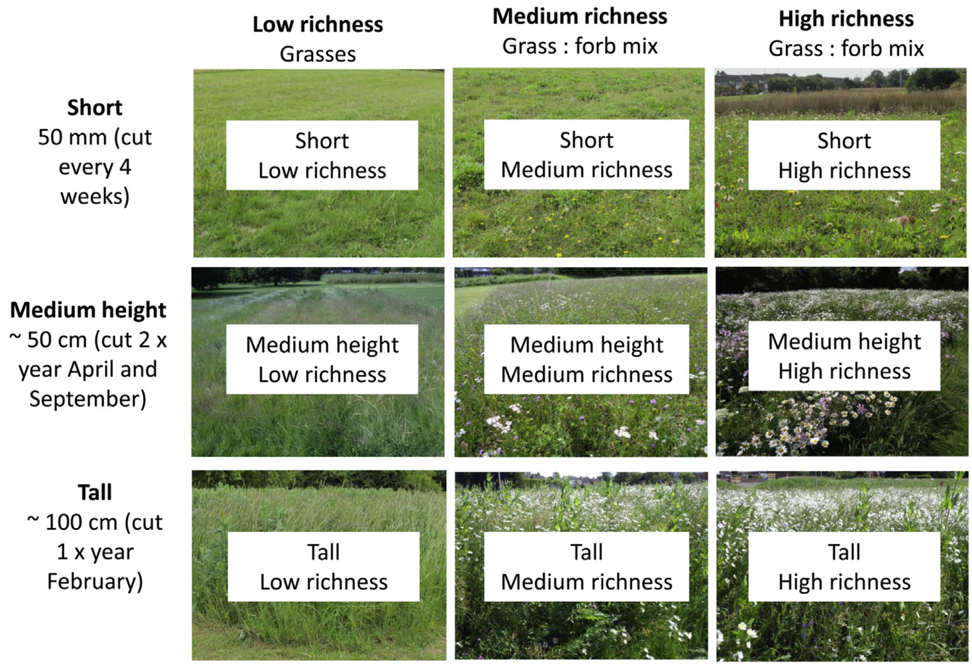

Fig. 1. The experimental design showing treatment variation across the two axes of plant structure and species richness. For precise information on the seed mixes used for each richness level, please see Table S1.

following poor germination and establishment. A full suite of nine treatments was created at each site when possible; however at two sites with limited space (Goldington Green and Brickhill Heights) a reduced suite of treatments was implemented that maximised representation of the extremes of structural diversity and plant species richness (for full treatment details see Table S2). Basic signage highlighting the purpose of the plots was introduced in June 2014. Site level questionnaires (Phase 1) were conducted during the first season of establishment, followed by plot level questionnaires (Phase 2) in the second season when the plots were fully established.

2.3. Greenspace user surveys

We used a two phase approach to quantify respondents' perceptions of meadow creation at i) the experimental site level (Phase 1) and ii) at the experimental plot level (Phase 2). During Phase 1 we conducted a photo elicitation study whereby we assessed respondents' general preference for meadow style planting in relation to other planting styles. We also assessed their site appreciation and perceptions of site quality. Phase 1 surveys were conducted at experimental and control sites, enabling us to assess the impact of meadow creation on site appreciation and quality. The Phase 2 study focused explicitly on the experimental meadow plots and quantified participants' responses to the different types of meadows that we created.

2.4. Phase 1 questionnaires: site level perceptions and early meadow establishment

A photo elicitation study was conducted at experimental and control sites during the establishment phase to assess site users' preference for meadow style plantings relative to other planting styles commonly used in parks. Respondents were asked to allocate a preference score of 1–10 (1 = they would not like to see this style used at the site, 10 = they would like to see it used at the site) to two generic images (i.e. they do not depict the experimental sites) per planting style (meadows, herbaceous borders and formal bedding planting; Fig. S2).

To assess whether visitors' perceptions of changes in site quality differed between control and experimental sites after meadows were created we asked respondents 'Do you feel that the site has changed in quality over the last year?' (scored on a five point Likert scale; 1 = strong decline in quality; 2 = slight decline; 3 = no change; 4 = slight improvement; 5 = strong improvement). To determine what had contributed to any perceived changes in quality we asked the open question 'What has caused this change?, followed by "Has this change altered your appreciation of the site?" (scored on a five-point Likert scale; 1 = large decline in appreciation; 2 = slight decline in appreciation; 3 = no change in appreciation; 4 = slight improvement in appreciation; 5 = large improvement in appreciation). We also collected data on respondents' age, income, employment status, education, postcode (from which we obtained the Multiple Index of Deprivation), and gender. We used open ended questions to assess how frequently respondents visited the site in a typical fortnight and the typical duration of these visits, then calculated the total amount of time spent at the site in a typical fortnight as a metric of site use. We also recorded the number of years that they had been visiting the site (visit history – an open ended question), the number of visits to the countryside per fortnight, and respondents' support for conservation based on the proportion of £600 they allocated to environmental protection and animal/plant conservation when given four alternative charitable sectors (medical research, human rights, animal welfare, and protecting/helping vulnerable people).

Surveys were conducted from June to August 2013 (30 respondents per site; $n = 300$), (with the exception of Brickhill Heights and Jubilee Park that were surveyed in June 2014 due to re-seeding in 2013) by approaching potential adult respondents in the green space whenever an interviewer became available. Questionnaires were almost entirely administered by the interviewer, although nine were self-completed to maximise the response rate (which was 76%). Questionnaires were conducted within and outside normal working hours to ensure that as broad a range of people were surveyed as possible.

2.5. Phase 2 questionnaires: meadow preference surveys

A second set of questionnaires were conducted in the second season after planting at four of the experimental sites (excluding Jubilee Park due to poor initial establishment) to assess how plant species richness and structural diversity were associated with respondents' preference scores (an indicator of aesthetic value). Questionnaires were conducted when the meadows were fully established and in full flower (July – August 2014, 30 questionnaires per site, $n = 120$), and then again at two sites (Chiltern Avenue and Bramingham Road) to assess the impact of seasonal change when the vegetation had died back and was decaying (February 2015, $n = 55$), and starting to grow again (April 2015, $n = 60$). These additional winter and spring surveys were conducted to assess seasonal variation in preferences for the three structural diversity treatments with medium plant species richness. Inclement weather during the winter made it difficult to recruit site visitors who were willing to assess all nine plots so the reduced suite of treatments was selected to standardise plant species richness, but capture the variation in structural diversity which was more immediately obvious than the variation in plant species richness outside the flowering season. However, the medium height plot was mown off during the winter as part of standard management practice so was similar in height to the short plots during the February surveys (Fig. S3). Respondents were selected using the same procedure as for the Phase 1 questionnaires, the response rates were 67% (summer), 57% (winter) and 68% (spring).

In each of the three survey periods respondents were asked to allocate a preference score from 1 to 10 to each plot (1 = strongly dislike, 10 = strongly like). To assess how providing information influenced tolerance of the meadows' winter appearance respondents were also asked how willing they were to tolerate the current appearance of each plot on a five point Likert scale (1 = strongly disagree – 5 = strongly agree) before and after being shown a) an image of the plot's appearance during the flowering period, b) information on the abundance of bees and butterflies in the plot (based on quantitative survey data conducted on the plots during the summer of 2014) and c) information on the relative mowing frequency of each treatment (Table S3).

We collected data on respondents' age, income, employment status, educational attainments, postcode (from which the Multiple Index of Deprivation was obtained), gender, typical visit frequency, visit duration, the number of years they had been visiting the site (visit history) and their use of the countryside. In order to investigate relationships between aesthetic preference and an individual's biodiversity knowledge and support for nature, information was collected on their plant identification knowledge. Respondents were asked to name nine common plant species: meadow buttercup *Ranunculus acris*, yellow rattle *Rhinanthus minor*, daisy *Bellis perennis*, wood sorrell *Oxalis acetosella*, bird's foot trefoil *Lotus corniculatus*, ribwort plantain *Plantago lanceolata*, field poppy *Papaver rhoeas*, field scabious *Knautia arvensis* and dandelion *Taraxacum officinale* (we accepted correct common or scientific names at genus or species level). As a measure of their support for nature we asked respondents if they would like to see the following wildlife features at the site, or had these features in their garden: nettle bed for butterfly caterpillars, bird nesting boxes, bird feeding stations, nesting homes for bees, bat boxes, water features, and a wood pile for hedgehogs and insects.

2.6. Data analysis

All analyses were performed using R (version 3.2.1) unless otherwise stated. For continuously distributed response variables we constructed linear mixed effects models (nlme package) with maximum likelihood parameter estimation. When response variables were ordinal data, i.e. Likert scale responses, we used cumulative link mixed models fitted with Laplace approximation (ordinal package). Our core objectives focus on testing people's responses to the experimental meadow treatments. We thus follow the advice of Whittingham, Stephens, Bradbury, and Freckleton (2006) and assess the significance ($P < 0.05$) of our treatment variables within full models that take potentially confounding variables into account (including socio-demographic factors, site use and indicators of respondents' engagement with nature, see below for more details).

We used Categorical Principal Components Analysis (CATPCA) in SPSS (version 22) to assess co-variation in respondents' income, educational attainment, employment status, ethnicity and multiple deprivation index for the two datasets collected in Phase 1 and Phase 2. The CATPCA analysis of the phase 1 survey data recovered two axes that together accounted for 58% of the variation. Variables loading positively onto the first axis (eigenvalue 1.68) were educational attainment (0.73), employment status (0.68) and income (0.77); we term this axis socio-economic status. Variables loading positively onto the second axis (eigenvalue 1.23) were multiple deprivation index (0.69) and ethnicity (0.68); we term this axis the ethnicity-deprivation index, with high values representing people that live in areas with higher deprivation scores and that are more likely to be of an ethnic minority. We found the same co-variance patterns in the Phase 2 data, with the two axes accounting for 62% of the variation. Variables loading positively onto the socio-economic status index (eigenvalue 1.61) were educational attainment (0.74), income (0.73) and employment status (0.71). Variables loading positively onto the ethnicity-deprivation index (eigenvalue 1.48) were the multiple deprivation index (0.76) and ethnicity (0.72). Respondents' scores on these two axes were used in all subsequent analyses.

2.6.1. Phase 1 surveys

To assess the relative preference for the three planting styles (meadows, herbaceous border and formal bedding plantings) we calculated each person's mean preference score ($n = 300$) across each style's two images. This mean preference score was then modelled, using linear mixed effect models, as a function of planting type (a three level fixed factor), site use (a continuous variable), the number of years they had been visiting the site (termed visit history – a continuous variable), countryside visitation rate (a continuous variable), support for conservation (a continuous variable), gender (a binary fixed effect), age, socio-economic status, ethnicity-deprivation index, and person (a random factor to take into account that each person gave a score for the three planting types). We constructed a model with only main effects and, in order to test potential interactions between socio-demographic factors and aesthetic preference, we also constructed a model that contained all main effects and interactions between planting type and socio-demographic variables (i.e. gender, age, socio-economic status and ethnic deprivation index). A second interaction model was also built that contained all main effects and interactions between planting type and measures of respondents' prior use of the site (site use and visit history), orientation towards the countryside (countryside visit frequency) and conservation (conservation support) in order to see if these altered aesthetic preferences

To determine whether meadow establishment altered perceived site quality we used cumulative link mixed models to model respondents' ($n = 300$) Likert scale responses as a function of treatment (meadow or control site), site use, visit history, countryside visitation rate, support for conservation, gender, age, socio-economic status, ethnic deprivation index, and site (as a random effect). We constructed a model that only included main effects, a model with main effects and the interactions between treatment and socio-economic variables, and a model with main effects and the interactions between treatment and site use, visit history, countryside visit frequency and support for conservation.

Finally, we used data from the five sites at which meadow plantings were introduced and from respondents who explicitly reported that the experimental meadows were responsible for the changes in site quality ($n = 65$). We used cumulative link models to model respondents' Likert scale responses regarding the impact of the meadows on their appreciation of the site as a function of site use, visit history, countryside visit frequency, conservation support, age, gender, socio-economic status, ethnicity deprivation index and site (as a random factor).

2.6.2. Phase 2 surveys

Prior to analysis, we conducted a Principal Component Analysis (PCA) in SPSS (version 22) to assess co-variation within the countryside and wildlife orientated variables collected for these surveys (countryside visit frequency, plant taxonomic knowledge and support for nature). The first axis (accounting for 43% of the total variation, eigenvalue of 1.28) had strong positive loadings for wildlife support (0.68), countryside visit frequency (0.66) and plant identification knowledge (0.62); we term this axis eco-centricity.

To assess whether preference scores for different types of urban meadows were associated with structural diversity and plant species richness we used cumulative linked mixed models that modelled each respondent's ($n = 120$) preference scores for each plot as a function of meadow treatment (a nine level fixed factor), site use, eco-centricity, gender, age, socio-economic status and ethnic deprivation. We constructed a model containing i) all main effects, ii) all main effects and all interactions between meadow treatment type and socio-demographic variables, and iii) all main effects and all interactions between meadow treatment type and respondents' site use and eco-centricity. As an additional test of whether aesthetic preferences were driven by changes in plant species richness or structural diversity we used cumulative link mixed models that modelled respondents' preference scores as a function of structure (short, medium and tall) and plant species richness (low, medium and high), site use, eco-centricity, gender, age, socio-economic status and ethnic deprivation. We constructed a model with only main effects, a model that included main effects and interactions between all socio-demographic variables and structure and richness, and a third model that included main effects and interactions between respondents' site use and eco-centricity and structure and richness.

2.7. Seasonality

We conducted Kruskal–Wallis tests to assess whether season influenced respondents' preference scores ($n = 60$), followed by post-hoc Mann-Whitney tests using Bonferroni-Holm correction (Holm, 1979). This analysis was confined to the three treatments that were surveyed in winter, spring and summer (short, medium and tall plots with medium plant species richness). To assess how providing information influenced willingness to tolerate meadow vegetation outside the flowering season we used Wilcoxon Signed Rank Tests to analyse paired Likert scale responses (1 = strongly disagree; 2 = disagree; 3 = neither agree or disagree; 4 = agree; 5 = strongly agree) before and after the receipt of information. We conducted four tests that compared tolerance scores before respondents were provided with any information with scores after: i) being shown an image of the plot during the flowering period; ii) being provided with information on the abundance of bees and butterflies in the plot during the summer; iii) being provided with information on the reduction in cutting frequencies attributable to the different treatments as compared with standard mown amenity grassland; and iv) considering all three pieces of information together.

3. Results

3.1. Preference for meadows relative to other planting styles

The meadow images received higher preference scores than images of herbaceous and formal bedding styles (Table 1; main effects only model). Consideration of interaction terms indicated that meadows were given higher preference scores by respondents who visited the countryside more frequently, had been visiting the site for a shorter period, were women and were people with lower ethnicity-deprivation scores than those without these characteristics (Table 1; models with interaction terms).

3.2. The impact of meadows on site quality and appreciation

Respondents were significantly more likely to report positive changes in site quality at sites where experimental meadow treatments were introduced than at control sites (Table 2; main effects only model). No other main effect terms (site use, visit history, countryside visitation rate, socio-economic status, ethnic deprivation, age or gender) had significant effects. Whilst people with higher ethnicity-deprivation scores tended to respond less positively to the treatment the significance was marginal, and no other interaction terms were significant (Table 2; models with interaction terms). 56% of respondents cited the meadow plots as the reason for site quality changes. Within this group 19% of respondents indicated that the meadows did not alter their appreciation of the site, which is surprising given that they previously stated that meadows increased site quality. Despite this four times as many people (65%) stated that the meadows had improved their appreciation of the site compared with those (16%) reporting that meadows had reduced their appreciation of the site. A main effects model, controlling for history and magnitude of site use, countryside visitation rate support for conservation and socio-demographic factors found that respondents who used the site more frequently and had higher ethnicity-deprivation scores were less likely to report greater appreciation of the site following establishment of the experimental meadows (Table 3).

3.3. Preference for experimental meadow treatments and effects of plant species richness

The model of respondents' plot preference scores as a function of treatment, site use, eco-centricity and a range of socio-demographic variables, indicates that all of the meadow treatments had higher preference scores than the replicate standard mown amenity grass treatment (i.e. short plots, low plant species richness; Fig. 2). Preference scores increased with plant species richness within plots of the same height. The most preferred treatment was that with the highest plant species richness and medium height (main effects model Table 4; Fig. 2). Preference scores for all types of meadows, relative to the replicate of mown amenity grassland (short mown, low richness), tended to be higher for respondents reporting higher eco-centricity (but significance was marginal; Table 4, main effects model). Models with interaction terms demonstrated that people with a higher ethnicity-deprivation score gave higher preference scores to all medium height and tall plots (other than the tall plot with low plant species richness), than people with lower ethnicity-deprivation scores (interaction model, Table 4). There were no significant interactions between treatment and site use, or between treatment and respondents' eco-centricity (interaction model, Table 4).

Table 1
Linear mixed effect model results of preference for planting type. Data reported are parameter estimates, their 95% confidence intervals and P values. Parameter estimates for treatment are expressed relative to formal plantings (set at zero), and for gender are expressed relative to women (set at zero).

Model	Planting type	Site use	Visit history	Countryside visit rate	Conservation support	Socio-economic status	Ethnicity deprivation	Age	Gender (male)	Planting type * site use	Planting type * visit history	Planting type * country-side visit rate	Planting type * con-servation support
Main effects only	*Herbaceous* 1.03 (0.545 to 1.506) P < 0.001 *Meadow* 2.65 (2.177 to 3.122) *P* < 0.001	0.01 (−0.0003 to 0.001) *P* = 0.52	−0.01 (−0.021 to 0.010) *P* = 0.49	0.01 (−0.053 to 0.065) *P* = 0.84	0.001 (−0.001 to 0.003) *P* = 0.17	−0.03 (−0.286 to 0.235) *P* = 0.85	0.34 (0.099 to 0.585) *P* = 0.01	−0.01 (−0.025 to 0.009) *P* = 0.35	−0.23 (−0.730 to 0.270)*P* = 0.31	–	–	–	–
Main effects and interactions between planting type, site use and countryside/ conservation orientation	*Herbaceous* 0.75 (−0.114 to 1.612) *P* = 0.09 *Meadow* 2.54 (1.698 to 3.391) *P* = 0.0001	−0.22 (−0.660 to 0.221) *P* = 0.33	−0.01 (−0.013 to −0.008) *P* = 0.41	−0.08 (−0.179 to 0.014) *P* = 0.09	−0.0004 (−0.003 to 0.002) *P* = 0.76	−0.03 (−0.289 to 0.231) *P* = 0.83	0.34 (0.094 to 0.579) *P* = 0.01	−0.01 (−0.025 to 0.009) *P* = 0.34	−0.22 (−0.660 to 0.221) *P* = 0.33	*Herbaceous*-0.001 (−0.002 to 0.000002) *P* = 0.05 *Meadow* −0.001 (−0.002 to −0.001) *P* = 0.001	*Herbaceous* 0.01 (−0.025 to 0.042) *P* = 0.63 *Meadow* 0.01 (−0.026 to 0.040) *P* = 0.67	*Herbaceous* 0.08 (−0.047 to 0.214) *P* = 0.21 *Meadow* 0.17 (0.046 to 0.303) *P* = 0.01	*Herbaceous* 0.02 (−0.001 to 0.007) *P* = 0.11 *Meadow* 0.01 (−0.002 to 0.006) *P* = 0.34

Model	Planting type	Site use	Visit history	Countryside visit rate	Conservation support	Socio-economic status	Ethnicity deprivation	Age	Gender (male)	Planting type * Age	Planting type * Gender	Planting type * Socio-economic status	Planting type * Ethnicity deprivation
Main effects and interactions between planting type, socio-demographic traits	*Herbaceous* 0.31 (−1.523 to 2.135) *P* = 0.74 *Meadow* 1.86 (0.066 to 3.653) *P* = 0.04	0.0001 (0.0003 to 0.0005) *P* = 0.53	−0.01 (−0.022 to 0.010) *P* = 0.48	0.01 (−0.053 to 0.066) *P* = 0.83	0.001 (−0.001 to 0.003) *P* = 0.18	0.08 (−0.340 to 0.492) *P* = 0.72	0.83 (0.453 to 1.217) *P* = 0.0001	−0.03 (−0.054 to −0.001) *P* = 0.05	0.85 (0.147 to 1.548) *P* = 0.02	*Herbaceous* 0.01 (−0.010 to 0.060) *P* = 0.17 *Meadow* 0.03 (−0.003 to 0.066) *P* = 0.07	Herbaceous −1.29 (−2.225 to −0.361) *P* = 0.01 *Meadow* −1.92 (−2.834 to −1.003) *P* = 0.0001	Herbaceous −0.26 (−0.819 to 0.297) *P* = 0.36 *Meadow* −0.04 (−0.589 to 0.506) *P* = 0.88	Herbaceous 0.49 (−0.995 to 0.017) *P* = 0.06 *Meadow* −0.97 (−1.471 to −0.475) *P* = 0.0002

Table 2
Cumulative link mixed model results of perceived changes in site quality in response to experimental meadow treatments. Data reported are parameter estimates, their 95% confidence intervals and P values. Parameter estimates for treatment are expressed relative to control sites (set at zero), and for gender are expressed relative to women (set at zero).

Model	Treatment	Site use	Visit history	Countryside Visit rate	Conservation support	Socio-economic status	Ethnicity deprivation	Age	Gender (male)	Treatment * Site use	Treatment * visit history	Treatment * countryside visit rate	Treatment * conservation support
Main effects only	1.58 (0.164 to 0.986) *P* = 0.03	−1.01 (−2.239 to 0.227) *P* = 0.11	0.15 (−0.071 to 0.369) *P* = 0.18	0.07 (−0.006 to 0.144) *P* = 0.07	−0.0003 (−0.003 to 0.002) *P* = 0.80	−0.0003 (−0.003 to 0.002) *P* = 0.80	−0.08 (−0.432 to 0.263) *P* = 0.63	−0.01 (−0.034 to 0.010) *P* = 0.28	−0.59 (−1.235 to 0.056) *P* = 0.07	–	–	–	–
Main effects and interactions between treatment and site use and countryside/ conservation orientation	1.68 (−0.043 to 3.399) *P* = 0.06	−0.001 (−0.002 to 0.0004) *P* = 0.24	0.001 (−0.030 to 0.032) *P* = 0.96	0.04 (−0.117 to 0.191) *P* = 0.64	0.002 (−0.002 to 0.005) *P* = 0.41	0.04 (−0.329 to 0.411) *P* = 0.83	−0.03 (−0.376 to 0.324) *P* = 0.88	−0.01 (−0.033 to 0.013) *P* = 0.39	−0.62 (−1.276 to 0.035) *P* = 0.06	−0.001 (−0.002 to 0.001) *P* = 0.27	0.02 (−0.025 to 0.060) *P* = 0.42	0.05 (−0.128 to 0.226) *P* = 0.59	−0.003 (−0.008 to 0.002) *P* = 0.30
Model	Treatment	Site use	Visit history	Countryside Visit rate	Conservation support	Socio-economic status	Ethnicity deprivation	Age	Gender (male)	Treatment * Age	Treatment * Gender	Treatment * Socio-economic status	Treatment * Ethnicity deprivation
Main effects and interactions between treatment and socio-demographic traits	2.43 (−0.236 to 5.094) *P* = 0.07	−0.001 (−0.001 to 0.0003) *P* = 0.001	0.001 (−0.012 to 0.033) *P* = 0.35	0.08 (−0.001 to 0.155) *P* = 0.05	−0.0001 (−0.002 to 0.002) *P* = 0.96	0.06 (−0.478 to 0.598) *P* = 0.83	0.36 (−0.155 to 0.867) *P* = 0.17	−0.001 (−0.033 to 0.032) *P* = 0.20	−0.66 (−1.651 to 0.340) *P* = 0.96	−0.02 (0.060 to 0.029) *P* = 0.50	−0.08 (−1.381 to 1.217) *P* = 0.90	−0.11 (−0.839 to 0.616) *P* = 0.76	−0.68 (−1.394 to 0.025) *P* = 0.06

Model	Treatment	Site use	Visit history	Countryside Visit rate	Conservation support	Socio-economic status	Ethnicity deprivation	Age	Gender (male)	Treatment * Age	Treatment * Gender	Treatment * Socio-economic status	Treatment * Ethnicity deprivation
Main effects and interactions between treatment and socio-demographic traits	2.43 (−0.236 to 5.094) *P* = 0.07	−0.001 (−0.001 to 0.0003) *P* = 0.001	0.001 (−0.012 to 0.033) *P* = 0.35	0.08 (−0.001 to 0.155) *P* = 0.05	−0.0001 (−0.002 to 0.002) *P* = 0.96	0.06 (−0.478 to 0.598) *P* = 0.83	0.36 (−0.155 to 0.867) *P* = 0.17	−0.001 (−0.033 to 0.032) *P* = 0.20	−0.66 (−1.651 to 0.340) *P* = 0.96	−0.02 (0.060 to 0.029) *P* = 0.50	−0.08 (−1.381 to 1.217) *P* = 0.90	−0.11 (−0.839 to 0.616) *P* = 0.76	−0.68 (−1.394 to 0.025) *P* = 0.06

Table 3
Cumulative link mixed model results of improved appreciation of the site following establishment of experimental meadow treatments. Data reported are parameter estimates, their 95% confidence intervals and P values. Parameter estimates for gender are expressed relative to women (set at zero).

Model	Site use	Visit history	Countryside visit rate	Conservation support	Socio-economic status	Ethnicity deprivation	Age	Gender (male)
Main effects only	−0.001 (−0.001 to 0.0001) $P = 0.02$	0.01 (−0.019 to 0.047) $P = 0.41$	0.05 (−0.036 to 0.143) $P = 0.24$	0.0003 (−0.003 to 0.004) $P = 0.89$	−0.08 (−0.572 to 0.418) $P = 0.76$	−0.51 (−1.011 to −0.008) $P = 0.04$	−0.01 (−0.046 to 0.016) $P = 0.36$	−0.47 (−1.368 to 0.428) $P = 0.30$

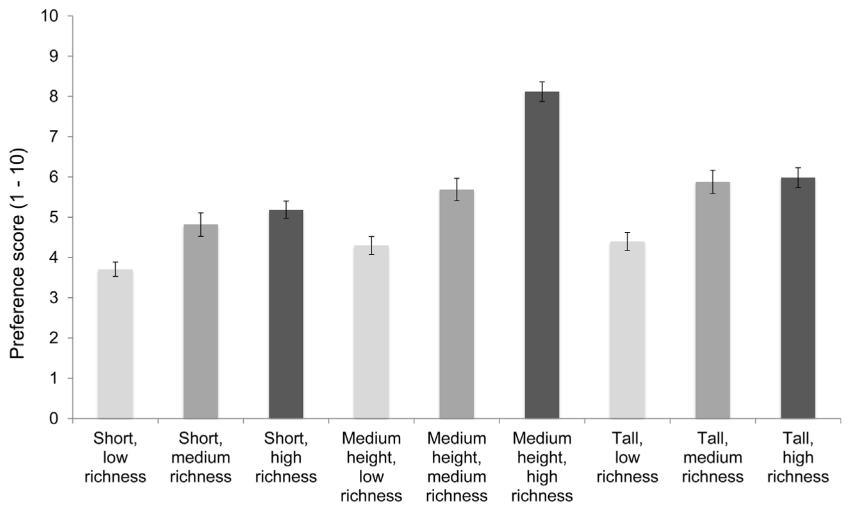

Fig. 2. Average preference scores for each meadow treatment (n = 120), error bars represent standard errors.

When models were constructed using structure and plant species richness as predictor variables (rather than the nine individual treatments) preference scores increased with plant species richness, and the medium height and tall plots were both preferred compared to the short plots, but the medium height plots were the most preferred (Table 5, main effects model). Respondents with higher eco-centricity scores also tended to give treatments higher preference scores than respondents with lower eco-centricity scores (but significance was marginal, Table 5). Interactions between treatment and socio-demographic variables revealed that people with higher ethnicity-deprivation scores gave higher preference scores to the medium height and taller plots, and to the more species rich plots, than people with lower ethnicity-deprivation scores (interaction model, Table 5). Higher preference scores were also given to the plots with more plant species by older people and women (interaction model, Table 5). There were no significant interactions between treatment and site use or eco-centricity (interaction model, Table 5).

3.4. *Seasonal changes in aesthetic preference and tolerance of winter plots*

Preference scores for the short, medium and tall plots with a medium richness of sown plant species were lowest in winter and highest in summer, with an intermediate preference score in spring (all seasonal comparisons were statistically significant; $P < 0.05$; Fig. 3).

At Bramingham Road the majority of respondents were willing to tolerate the appearance of all three surveyed plots during the winter before being provided with any information (medium richness short: 64%; medium richness, medium height 80%; medium richness, tall 60%). Providing respondents with images of the plots during the flowering period reduced respondents' willingness to tolerate the short, medium richness plots during winter (Table 6), which out of the three plots included in the winter survey had the lowest preference score during summer surveys. Providing information on the value of the plots for bees and butterflies increased respondents' willingness to tolerate the tall medium richness plots (Table 6), which out of the three plots was the one with the greatest number of bees and butterflies. Providing information on the frequency of mowing needed to maintain the plots reduced respondents' willingness to tolerate the winter appearance of the short medium richness plots (Table 6), which were the ones that required the greatest mowing frequency. When considering all information types together there was only a significant increase in willingness to tolerate the tall medium richness plots (Table 6).

Before being provided with information the majority of respondents at Chiltern Avenue were willing to tolerate the winter appearance of the short medium richness plots (57%) and the tall medium richness (50%), but only 33% of people were willing to tolerate the medium height, medium richness plots. Providing information did not alter respondents' willingness to tolerate the short medium richness plot. All information types led to significantly higher tolerance of the medium height medium richness plot, and a similar result was obtained for the tall medium richness plot (but significance levels were marginal for the image of the plot flowering, and when considering all information together; Table 6).

4. Discussion

4.1. *Meadow preference relative to other planting styles*

Photo elicitation demonstrated that respondents preferred meadows to herbaceous borders or formal bedding in their local urban green-space. Despite concerns that naturalistic vegetation may not be an appropriate choice for urban areas as it can appear disordered and scruffy (Gobster, 1994; Nassauer, 1995, 2011), our findings indicate that on average people are receptive to the idea of naturalistic vegetation in urban green-spaces. This endorses the view that people prefer natural over highly managed

Table 4

Cumulative link mixed model results of preference scores (1 −10) in response to experimental meadow treatments (main effects model and interaction models). Data reported are parameter estimates, their 95% confidence intervals (CI) and P values. Treatment is expressed relative to short, low plant species richness (i.e. the mown amenity grassland replicate, set at zero). Gender is expressed relative to women (set at zero). Overall P values for treatment and interaction terms are in bold.

Main effects only

Variables	Parameter estimate	Lower CI	Upper CI	P value
Treatment	–	–	–	**0.0001**
Short, medium richness	1.08	0.480	1.687	0.0004
Short, high richness	1.33	0.849	1.816	<0.001
Medium height, low richness	0.56	0.046	1.083	<0.001
Medium height, medium richness	1.82	1.234	2.416	<0.001
Medium height, high richness	4.26	3.659	4.866	<0.001
Tall, low richness	0.66	0.180	1.142	0.007
Tall, medium richness	1.99	1.444	2.543	<0.001
Tall, high richness	2.09	1.585	2.594	<0.001
Site Use	– 0.0004	−0.002	0.001	0.58
Eco-centricity	0.61	0.316	0.901	<0.001
Gender (male)	0.21	−0.318	0.747	0.43
Age	0.0003	−0.023	0.024	0.98
Socio-economic status	−0.10	0.429	0.223	0.54
Ethnicity-deprivation	0.33	−0.025	0.676	0.07

Main effects & interactions with socio-demographic traits

Variables	Parameter estimate	Lower CI	Upper CI	P value
Treatment	–	–	–	**0.0001**
Short, medium richness	0.21	−2.500	−2.925	0.88
Short, high richness	0.51	−1.511	2.540	0.62
Medium height, low richness	0.31	−1.943	2.553	0.79
Medium height medium richness	−0.95	−3.510	1.606	0.47
Medium height, high richness	3.72	1.377	6.056	0.002
Tall, low richness	0.06	−1.964	2.090	0.95
Tall, medium richness	0.76	−1.492	3.022	0.51
Tall, high richness	−0.40	−2.416	1.620	0.70
Site Use	−0.0003	−0.0019	−0.0013	0.68
Eco-centricity	0.64	0.328	−0.960	<0.001
Gender (male)	1.04	0.158	1.927	0.02
Age	−0.03	−0.069	−0.004	0.08
Socio-economic status	−0.36	−0.887	0.177	0.19
Ethnicity- deprivation	−0.43	−0.981	−0.129	0.13
Treatment *Ethnicity −deprivation	–	–	–	**0.01**
Short, medium richness	0.55	−0.395	1.503	0.25
Short, high richness	0.49	−0.151	1.133	0.13
Medium, low richness	0.86	0.156	1.561	0.02
Medium height, medium richness	1.53	0.643	2.415	0.01
Medium, high richness	1.25	0.509	2.000	0.01
Tall, low richness	0.31	−0.351	0.974	0.36
Tall, medium richness	1.19	0.430	1.956	0.00
Tall, high richness	1.31	0.665	1.947	<0.001
Treatment * Gender	–	–	–	**0.08**
Treatment * Age	–	–	–	**0.65**
Treatment * Socio-economic traits	–	–	–	**0.56**

Main effects and interactions with site use & eco-centricity

Variables	Parameter estimate	Lower CI	Upper CI	P value
Treatment	–	–	–	**<0.001**
Short, medium richness	0.90	0.128	1.679	0.02
Short, high richness	1.15	0.532	1.774	0.0002
Medium height, low richness	0.46	−0.223	1.143	0.19
Medium height, medium richness	1.75	1.002	2.496	<0.001
Medium height, high richness	4.39	3.624	5.149	<0.001
Tall, low richness	0.67	0.049	1.296	0.03
Tall,medium richnesss	2.14	1.449	2.831	<0.001
Tall, high richness	2.37	1.709	3.023	<0.001
Site Use	−0.0005	−0.003	0.002	0.68
Eco-centricity	0.58	0.120	1.045	0.01
Gender (male)	0.22	−0.322	0.761	0.43
Age	0.0002	−0.024	0.024	0.98
Socio-economic status	−0.11	−0.442	0.221	0.51
Ethnicity-deprivation	0.34	−0.019	0.696	0.06
Treatment * Site use	–	–	–	**0.93**
Treatment*Eco-centricity	–	–	–	**0.12**

Table 5
Cumulative link mixed model results of preference scores (1 –10) in response to treatment structure and richness as separate predictors (main effects model and interaction models). Data reported are parameter estimates, their 95% confidence intervals (CI) and P values. Parameter estimates for treatment are expressed relative to short plots (structure) and those with low plant species richness. Overall *P* values for treatment and interaction terms are in bold.

Main effects only

Variable	Parameter estimate	Lower CI	Upper CI	P value
Treatment (structure)	–	–	–	**0.0001**
Medium height	1.39	1.055	1.727	<0.001
Tall	0.74	0.438	1.045	<0.001
Treatment (richness)	–	–	–	<0.001
Medium	1.16	0.810	1.501	<0.001
High	1.91	1.597	2.225	<0.001
Site Use	−0.0004	−0.002	0.001	0.58
Eco-centricity	0.59	0.311	0.878	<0.001
Gender (male)	0.21	−0.303	0.730	0.42
Age	−0.0004	−0.023	0.022	0.98
Socio-economic status	−0.09	−0.410	0.221	0.56
Ethnicity-deprivation	0.31	−0.032	0.647	0.08

Main effects and interactions with socio-demographic traits

Variable	Parameter estimate	Lower CI	Upper CI	P value
Treatment (structure)	–	–	–	**0.0001**
Medium height	0.89	−0.572	2.350	0.23
Tall	−0.08	1.371	1.201	0.90
Treatment (richness)	–	–	–	**<0.001**
Medium	0.01	−1.492	1.514	0.99
High	0.85	−0.404	2.104	0.18
Site Use	−0.0002	−0.002	0.001	0.75
Eco-centricity	0.62	0.320	0.921	<0.001
Gender (male)	1.17	0.431	1.909	0.002
Age	−0.04	−0.068	0.005	0.02
Socio-economic status	−0.52	−0.960	0.071	0.02
Ethnicity-deprivation	−0.51	−0.982	0.032	0.04
Treatment (structure) * Ethnicity deprivation	–	–	–	**0.0008**
Medium height	0.86	0.396	1.322	0.0002
Tall	0.531	0.110	0.952	0.01
Treatment (richness) * Gender (male)	–	–	–	**<0.001**
Medium	−0.39	−1.096	0.318	0.28
High	−1.56	−2.176	−0.953	<0.0001
Treatment (richness) * Age	–	–	–	**0.004**
Medium	0.03	−0.001	0.061	0.06
High	0.04	0.016	0.06	0.001
Treatment (richness) * Ethnicity-deprivation	–	–	–	**0.002**
Medium	0.70	0.188	1.223	0.007
High	0.63	0.240	1.033	0.001

Main effects and interactions with site use and eco-centricity

Variable	Parameter estimate	Lower CI	Upper CI	P value
Treatment (structure)	–	–	–	**<0.001**
Medium height	1.46	1.041	1.889	<0.001
Tall	0.99	0.599	1.373	<0.001
Treatment (richness)	–	–	–	**<0.001**
Medium	1.19	0.763	1.622	<0.001
High	1.95	1.557	2.343	<0.001
Site Use	0.0005	−0.001	0.002	0.64
Eco-centricity	0.48	0.090	0.867	0.002
Gender (male)	0.22	−0.306	0.738	0.42
Age	−0.0008	−0.024	0.022	0.95
Socio-economic status	−0.09	−0.414	0.225	0.56
Ethnicity-deprivation	0.32	−0.028	0.660	0.07
Treatment (structure) * Site use	–	–	–	**0.11**
Treatment (structure) * Eco-centricity	–	–	–	**0.09**
Treatment (richness) * Site Use	–	–	–	**0.96**
Treatment (richness) * Eco-centricity	–	–	–	**0.15**

Table 6
Results from Wilcoxon rank tests of respondents' willingness to tolerate the winter appearance of meadow treatments before and after the receipt of information on summer flowering performance, abundance of bees and butterflies and relative mowing frequencies. Responses were made on a five point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree or disagree, 4 = agree, 5 = strongly agree).

Bramingham Road (Luton)	Short, medium plant richness			Medium height, medium plant richness			Tall, medium plant richness		
Treatment	Likert score Median (mode)	Test statistic (V)	*P* value	Likert score Median (mode)	Test statistic (V)	*P* value	Likert score Median (mode)	Teststatistic (V)	*P* value
Before information	4 (4)	–	–	4 (4)	–	–	4 (4)	–	–
After visual information	4 (4)	15	0.03	4 (4)	5.5	0.28	4 (4)	7	0.20
After bee and butterfly abundance information	4 (4)	17	0.16	4 (4)	7.5	0.12	4 (4)	9	0.04
After mowing frequency information	3 (4)	28	0.01	4 (4)	14	0.56	4 (4)	9.5	0.26
After all information	4 (4)	19	0.38	4 (4)	9.5	0.43	4 (4)	0	0.02
Chiltern Road (Bedford)	Short, medium plant richness			Medium height, medium plant richness			Tall, medium plant richness		
Treatment	Likert score Median (mode)	Test statistic (V)	*P* value	Likert score Median (mode)	Test statistic (V)	*P* value	Likert score Median (mode)	Teststatistic (V)	*P* value
Before information	4 (4)	–	–	2 (2)	–	–	4 (4)	–	–
After visual information	4 (4)	26.5	0.92	2 (2)	0	0.0001	4 (4)	10	0.052
After bee and butterfly abundance information	4 (4)	37.5	0.90	4 (4)	0	0.0002	4 (4)	5.5	0.002
After mowing frequency information	3.5 (4)	37.5	0.90	4 (4)	0	0.0002	4 (4)	4	0.01
After all information	3.5 (4)	42	0.41	4 (4)	4	0.0007	4 (4)	10	0.052

Chiltern Road (Bedford)	Short, medium plant richness			Medium height, medium plant richness			Tall, medium plant richness		
Treatment	Likert score Median (mode)	Test statistic (V)	*P* value	Likert score Median (mode)	Test statistic (V)	*P* value	Likert score Median (mode)	Teststatistic (V)	*P* value
Before information	4 (4)	–	–	2 (2)	–	–	4 (4)	–	–
After visual information	4 (4)	26.5	0.92	2 (2)	0	0.0001	4 (4)	10	0.052
After bee and butterfly abundance information	4 (4)	37.5	0.90	4 (4)	0	0.0002	4 (4)	5.5	0.002
After mowing frequency information	3.5 (4)	37.5	0.90	4 (4)	0	0.0002	4 (4)	4	0.01
After all information	3.5 (4)	42	0.41	4 (4)	4	0.0007	4 (4)	10	0.052

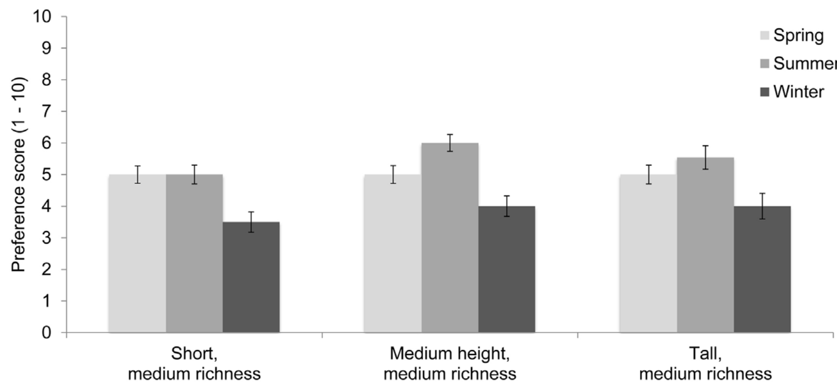

Fig. 3. Seasonal preference scores for each plot with medium plant species richness. Error bars represent standard errors. Kruskal-Wallis test for seasonal significance: medium richness short (X^2 14.6, $P<0.0001$); medium richness and medium height (X^2 22.6, $P<0.0001$); medium richness tall (X^2 47.7, $P<0.0001$). All post-hoc tests were significant–medium richness short: cf. winter and spring ($P<0.001$), cf. spring and summer ($P<0.05$); medium richness medium height: cf. winter and spring ($P<0.001$), cf. spring and summer ($P<0.001$); medium richness tall: cf. winter and summer ($P<0.001$) and spring and summer ($P<0.001$).

vegetation when given the choice (Hands & Brown, 2002; Kaplan, 2007). The effects were strongest in women (as found in previous studies: Lindemann-Matthies et al., 2010; Strumse, 1996) and people with lower ethnicity-deprivation scores, although the underlying drivers remain unclear. People that had been visiting the sites over a longer period, and were thus more likely to be personally attached to the sites in their pre-existing condition, were less receptive to the meadows. Negative attitudes to localised environmental changes can be linked to the phenomenon of 'place attachment' (the affective link that people establish with a specific environment: Schroeder, 1991), with proposed or actual developments perceived as a threat to the physical fabric and stability of a neighbourhood (Kyle, Graefe, Manning, & Bacon, 2004; Manzo & Perkins, 2006). The range of characteristics of local residents', particularly their sense of place, thus influences reactions to meadow creation in urban green-space, and whilst we find that people typically responded positively to meadows this variation in responses must be taken into account during the planning phase.

Our photo-elicitation study also found that images of meadows, relative to herbaceous borders or formal bedding planting, were most preferred by people who visited the countryside more frequently, suggesting that prior experience of naturalistic vegetation will increase people's appreciation of meadows (Beery & Wolf-Watz, 2014). Our results are therefore compatible with previously voiced concerns and empirical findings indicating that reduced exposure to the countryside may reduce support for conservation management (Beery & Wolf-Watz, 2014; Schultz, Shriver, Tabanico, & Khazian, 2004; Zelenski, Dopko, & Capaldi, 2015).

4.2. Site quality and appreciation

The local environment, including the availability and type of green-space, has an important impact on people's quality of life (Sugiyama et al., 2010; Ward Thompson & Aspinall, 2011). Respondents were significantly more likely to report improved site quality and appreciation of urban green-spaces in which meadows were created than at control sites, and the majority of respondents identified meadow creation as the factor driving these improvements. Our results relate to the first year of meadow establishment, contrasting with the view that initial implementation of naturalistic plantings in urban areas is often perceived negatively (Hands & Brown 2002), perhaps because meadow creation is a sign of stewardship or care, increasing site appreciation (Nassauer, 2011). Appreciation and perceptions of improved quality could also be enhanced by what Shwartz et al. (2014) term the subconscious benefits that people derive from interaction with or exposure to enhanced biodiversity. Perceived improvements to sites were not as marked amongst respondents that spent most time at the site or those with higher ethnicity-deprivation scores. The former suggests that respondents with a particularly strong sense of place attachment to a focal site may be more resistant to change (Brown & Perkins, 1992; Fried, 2000), even when potentially beneficial (Devine-Wright, 2009).

4.3. Aesthetic preference of meadow vegetation

All of our meadow treatments were preferred to the standard mown amenity grass replicate, contrasting with the view that positive cultural attitudes towards mown grass are deeply entrenched and resistant to change (Nassauer, 1995; Smith & Fellowes, 2015). The strength of preference for meadow treatments relative to the mown amenity grassland replicate was greatest in people with the highest eco-centricity scores. This finding parallels the Phase 1 finding that preference for meadows relative to herbaceous borders and formal bedding planting was greatest for people who visited the countryside most frequently. Meadows that contained more plant species had the highest preference scores in analyses conducted at the treatment level and when using structural diversity and plant species richness as independent predictors, thus confirming the aesthetic preference for diverse vegetation found in previous studies (Lindemann-Matthies & Bose, 2007; Lindemann-Matthies et al., 2010). The presence of flowering forbs in plots with medium plant species richness, but not low richness plots, probably contributes to the higher preference scores in the former. During the surveys the medium and high species richness plots did, however, contain a similar number of actively flowering forbs but preference scores were significantly higher in the high richness plots providing evidence for an effect of species richness per se. These findings support a link between ecological values and attitudes and preference towards management actions which increase biodiversity, such as meadow creation (Beery & Wolf-Watz, 2014; Schultz et al., 2004; Zelenski et al., 2015). Indeed, this preference for the more diverse meadow assemblages likely also reflects a human tendency to associate flowers and diverse vegetation compositions with aesthetic quality and psychological wellbeing (Haviland-Jones, Rosario, Wilson, & McGuirem, 2005; Todorova, Asakawa, & Aikoh, 2004). Our results are thus compatible with wider studies documenting positive associations between perceived or actual biodiversity and cultural ecosystem services, including well-being (Dallimer et al., 2012; Fuller et al., 2007).

The preference for plots with more plant species was stronger for older people and women. The latter pattern is somewhat similar to women's greater preference for meadows over formal planting and herbaceous borders, although stronger preference in women for species rich meadows may partly be because women are generally more appreciative of flowers than men (Van den Berg & van Winsum-Westra, 2010). The relationship with age may be driven by older people's greater experience of meadows from a time when they were more abundant (Lindemann-Matthies & Bose, 2007), and greater horticultural (Connell, 2004), or environmental awareness as part of the emotional and spiritual development of a person throughout their life course (Jorgensen & Anthopoulou, 2007).

Additionally, despite reporting a decreased sense of site appreciation following the initial establishment of the meadows, people with higher ethnicity-deprivation were significantly more likely to prefer the meadow plots containing higher structural diversity and higher plant species richness. This implies that once the meadows had fully established, people within this group were able to appreciate and derive the benefits arising from habitat creation. Indeed, studies show that lower socio-economic groups are significantly more likely to derive benefits from quality urban green-space than other groups living in cities, and this is posited to be due to an increased sensitivity to physical environmental characteristics (Maas, Verheik, Groenewegen, de Vries, & Spreewenberg, 2006).

Short meadows were the least preferred type, with preference scores typically being greatest for medium height meadows. Structural vegetation diversity typically increases invertebrate biodiversity (Brose, 2003), so these results provide some further evidence for positive associations between biodiversity and aesthetic value. The preference for plots of intermediate height may result from a trade-off between the increased aesthetic value of taller more natural vegetation of greater biodiversity value, and concerns that tall vegetation is unkempt, a sign of neglect and possibly a safety concern (Lindemann-Matthies & Bose, 2007; Liu, 2002; Jorgensen, Hitchmough, & Calvert, 2002).

4.4. Seasonality

Respondents gave lower preference scores to the meadow plots during winter than spring and summer, when preference peaked, presumably due to seasonal differences in greenness and flowering (Abello & Bernaldez, 1986; Junge, Schuepbach, & Walter, 2015). Despite these lower preference scores respondents were generally willing to tolerate the appearance of meadows during the winter. Providing additional information on the plots' benefits and appearance during summer reduced tolerance for plots that offered fewer benefits, i.e. the short plots, but significantly increased tolerance for taller plots that had lower winter preference scores but offered greater aesthetic benefits, insect abundance and reductions in mowing frequency over the summer. Information provision will thus be particularly important for increasing site users' acceptance of meadow creation in urban green-space, particularly when they have a strong sense of place attachment and limited knowledge of, or prior exposure to meadow vegetation.

5. Conclusion

Photo elicitation and experimental meadow creation demonstrate that there is widespread support for creating meadows in urban green-spaces. We found few barriers to the acceptance of meadows, with all types of meadows being preferred relative to a replicate of mown amenity grassland. In addition, creating meadows in urban green-space increased visitors' perceived site quality and site appreciation. There was variation in people's responses to meadows with those that visit the countryside more frequently and those with greater eco-centricity responding more positively and respondents that are more attached to a site responding less positively. Meadows that contained more plant species and provided some structural diversity had the highest preference scores, and providing information on meadows' benefits (including their biodiversity value) increased respondents' willingness to tolerate meadows during the winter. There are thus positive associations between aesthetic and biodiversity values and re-designing urban green-spaces through meadow creation can provide a win–win strategy for biodiversity and people and potentially improve connections between the two.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.landurbplan.2016.08.003.

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